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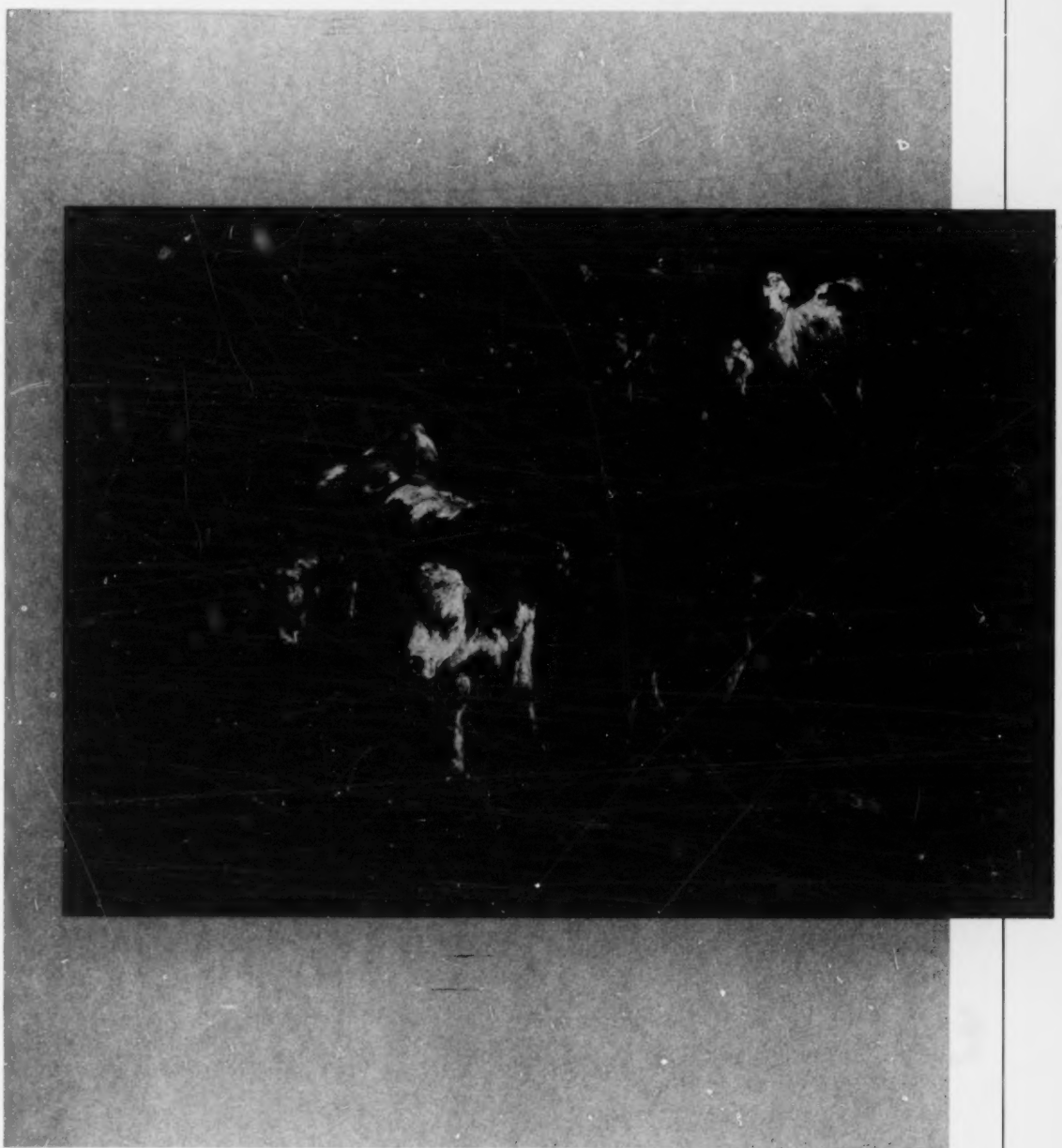

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VBPA

Survey measures technician activities

The North American Veterinary Technician Association (NAVTA), founded to represent and support veterinary technicians, received a grant from Hill's Pet Products, Inc, to conduct a national survey assessing the demographics and current opinions of the veterinary technology profession. A questionnaire was developed and distributed, and data were tabulated with the assistance of Dr. Karl Wise of the AVMA Center for Information Management.

For the purpose of this study, a veterinary technician was defined as a graduate of an AVMA–accredited program or someone who is credentialed by his/her state through examination as a certified, licensed, or registered veterinary technician.

The survey was distributed to 3,450 persons within these three groups. Group One, identified as members, comprised 1,198, 1991 NAVTA members. Group Two, identified as nonrenewals, comprised 266, 1990 NAVTA members who did not renew in 1991. Group Three, identified as nonmembers, was made of randomly selected subscribers to *Veterinary Technician*. The response rate to the survey was 47%.

To assess the profile, the three target groups were evaluated on the basis of gender, age, and duration of employment. Of the 1,616 respondents, 95% were female, with a mean age of 31. The average duration of employment as a veterinary technician was seven years. Respondents worked for an average of two employers since beginning their career and indicated they worked approximately 40 hours per week.

The data indicated that the majority of respondents work in the Northeast (30%) and Midwest (30.5) regions. Eighteen percent of respondents were from the South region and 21.5% hail from the West.

Respondents were asked to indicate the size of their community and practice type. The following information indicates distribution according to community size:

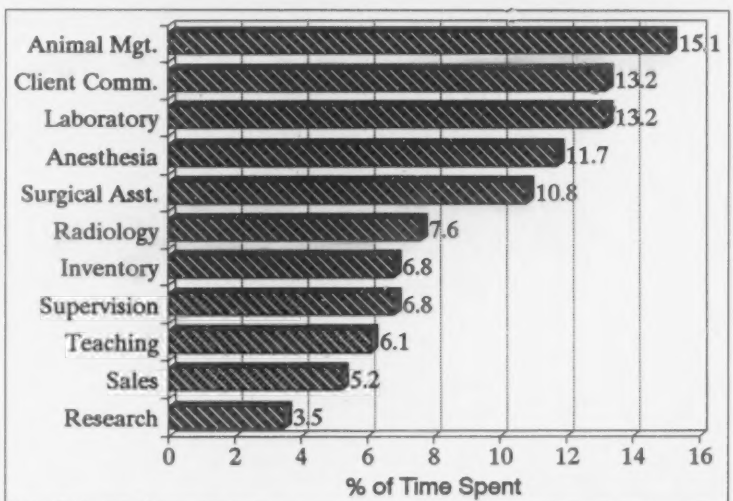
Rural area (population < 2,500)	5.4%
Small community (population 2,500-50,000)	34.0%
Moderate urban area (population 50,001-500,000)	37.3%
Large urban area (population > 500,001)	23.3%

Fifty percent of all respondents indicated that they are employed in companion animal practice, 16% in mixed animal practice, with an even distribution of less than 6% in each of 12 other categories.

The respondents who work in private practice indicated that there were an average of three veterinarians, two veterinary technicians, and three other assistants on staff where they were employed. In another question, 66% of respondents indicated that the computer played a role in the practice, with 80% using the computer for client records, 46% for inventory, 40% for word processing, and 28% for data analysis.

Respondents then were asked to estimate the percentage of their day spent in the performance of 11 tasks. The data indicate that a majority of the respondent's time is spent in the areas of animal management, client communications, and laboratory procedures.

To identify changes in the time allocated to perform these tasks, respondents were asked: What activity takes up more of your time on the job today than it did three years ago? Twenty-one percent of the respondents indicated that client communications takes up more of their time on the job than it did three years ago. Fourteen percent indicated that more of their time is allocated to perform inventory/ordering tasks, 13% for supervision of staff, and 10% for laboratory activities, when compared with three years ago. These data suggest that, as the veterinary technology profession matures, the veterinarian is delegating more of the practice management tasks to the technician. They also indicate that practice management is an avenue of career advancement for the veterinary technician in private practice.



According to the NAVTA survey, technicians spend more time in animal management than in any other task.

Written by A. Patrick Navarre, RVT, a veterinary technology instructor and operating room supervisor in the Large Animal Clinic at Purdue University in West Lafayette, Ind, and Carlene Decker, CVT, a veterinary technology instructor at Parkland College in Champaign, Ill. They are the NAVTA Task Force members responsible for implementing the grant from Hill's to conduct the national survey.

Description and evaluation of the influence of veterinary presence on the use of antibiotics and sulfonamides in dairy herds

John B. Kaneene, DVM, MPH, PhD, and RoseAnn Miller, BS

Summary: *A longitudinal study was conducted over 2 years to identify types of antibiotics and sulfonamides used in Michigan dairy herds for disease prevention and treatment, to determine patterns of use of antibiotics and sulfonamides by herd size and animal age group, and to determine the influence of veterinary presence during diagnosis on the types of antimicrobials used for disease treatments.*

In order of frequency, the most commonly used preventive antibiotic and sulfonamides were penicillins, tetracyclines, aminoglycosides, and cephalosporins, making up over 86% of all antimicrobials used for disease prevention. The most commonly used therapeutic antibiotics and sulfonamides were penicillins, tetracyclines, aminoglycosides, and sulfonamides, making up over 81% of all antimicrobial drugs used for disease treatment. Cows received the greatest number of drugs, followed by calves (cattle from birth to weaning). Young stock (cattle from weaning to first calving) received the lowest number of drugs. All herds had similar patterns of drug use for the 3 age groups, regardless of herd size.

With the exception of polymyxin and chloramphenicol, producers used antibiotics on their own more than with a veterinarian present or on the advice of a veterinarian. Overall, veterinary presence was significantly associated with increased use of tetracyclines, sulfonamides, and nitrofurans, and decreased use of penicillins and aminoglycosides. Implications for drug residue prevention strategies are discussed, with emphasis on the role of the practicing veterinarian.

The use of antimicrobial drugs in modern dairy farms is common. These products are used in high doses to treat sick animals, lower doses to prevent disease, and in subtherapeutic doses to improve growth and feed efficiency.[1] It has been estimated that 75% of all dairy calves marketed in the United States have received antibiotics at some time in their lives.[2] With the potential for human health hazards from residues, the use of antimicrobials in food animals is of concern to consumers and producers.[3-8] Similarly, the potential for economic damage from residues to the milk processing industry is a major concern.[3,5] Recent studies have found detectable residues in 63% of milk sampled from store shelves in the northeastern United States,[3] whereas residues rates of 33% were found in the western United States.[9] In a recent survey,[3] the most commonly found antimicrobial drugs in milk were sulfonamides and tetracyclines, and, in another study,[4] sulfonamides, penicillins, aminoglycosides, cephalosporins, and chloramphenicol were the most commonly found. Practices that contribute to residues in milk include the use of feed additives,[3,4,6,7,10] producers not following withholding times,[4,7,10-12] misuse of drugs,[7] use of temporary labor at the farm,[10] and poor animal records and identification.[10,12] The use of antimicrobial drugs to control mastitis is considered to be one of the primary sources of residues in milk.[3,4,11]

Livestock producers and the professionals that serve the industry will have to work together to meet the growing demand for higher standards of food safety from consumers. One of the areas of interdisciplinary cooperation should be in the documentation of types of drugs that are used on farms, and the circumstances under which they are used. Information that identifies how these drugs are being used can be helpful to pinpoint specific practices that lead to residue problems.

The objectives of the study reported here were to identify types of antibiotics and sulfonamides most commonly used in Michigan dairy herds for disease prevention and treatment, to determine patterns of use of antibiotics and sulfonamides by herd size and age group, and to determine the influence of veterinary presence during diagnosis on the types of antimicrobials used for disease treatments.

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The authors thank the veterinary medical officers of the Michigan Department of Agriculture, USDA-APHIS-VS, and Michigan State University for their essential role in collecting the data; and veterinary practitioners for providing information on disease diagnoses and treatments.

Materials and Methods

The data used for this study were collected using the Michigan National Animal Health Monitoring System (NAHMS), a cooperative state, federal, and industry effort to provide statistically sound estimates of animal health events and associated costs in selected states. The design, herd characteristics, and data collection procedures have been reported earlier.[13] Briefly, NAHMS conducted a longitudinal study in which individual farms were studied for a 12-month period. Michigan dairy producer data were collected in 2 rounds: from June 1986 to June 1987, and from January 1988 to January 1989. Data were collected at 3 phases of dairy producer involvement: an initial survey and management survey at the beginning of producer participation; monthly animal health events during the course of the round; and the same management survey at the end of producer participation. The initial survey was administered before monthly animal health event data collection began, and collected data on general herd management. The monthly data, collected by veterinary medical officers included the herd inventory, reproductive events, preventive measures administered, and disease on the farm for the previous calendar month. Preventive measure data consisted of the types of diseases being prevented, the preventive measures, the age group, and the number of animals receiving the measures. Disease data included the disease, who diagnosed the disease in animals, numbers of cases, outcomes, and treatments used. In addition, adult cow disease records for each cow were maintained on a separate worksheet.

Antibiotics and sulfonamides—The veterinary medical officers were asked to record either brand names or generic equivalents of products used for treatment or prophylaxis. Both types of information were stored on computer, and efforts were made to identify the contents of treatments identified by a product name. Statistical analyses were performed on the basis of the active ingredients of products. Whenever possible, antibiotic and sulfonamides were grouped as either aminoglycosides, bacitracin, cephalosporins, lincomycin, macrolides, nitrofurans, novobiocin, penicillins, polymyxins, spectinomycin, tetracyclines, and sulfonamides. In some circumstances, treatments were preparations made by the producer's veterinarian, who identified the treatment with their own name (ie, "Red Ram", "Blue"). When this occurred, the veterinary medical officer contacted the producer's veterinarian for a list of the active ingredients in the treatment.

Animal-months were computed from herd inventories as the sum of the number of live animals reported in the herd at the end of any given month. There were 13,610 calf-months, 90,243 young stock-months, and 99,863 cow-months covered in the 2 rounds.

Preventive drugs—Because the number of head receiving a preventive drug was recorded in all age groups each month, it was possible to compute the number of animal-months receiving preventive drugs. Counting each animal receiving preventive drugs was not possible, because each animal was not identified and it is possible for an animal to receive such a drug more than once during the month.

Treatment drugs—Because the worksheet monitored adult cows on an individual basis, it was possible to count animal-months actually receiving a treatment for disease. However, this was not possible for calves (animals from birth to weaning) and young stock (animals from weaning to first calving), because the only disease information collected for these age groups were monthly inventories, which captured the numbers of sick, recovered, dead, and culled animals. There was no provision for identifying which animals received what treatment, if any. In an effort to capture the number of uses of antimicrobial drugs for treatment in these 2 age groups, the number of head that might possibly have received treatment was used as an estimator for drug use.

Patterns of antibiotic and sulfonamide use were examined by using equation 1:

$$\text{Proportional drug use} = \frac{\text{NMonths}_{XY}}{\text{NMonths}_{X}} \times 100$$

where NMonths_{XY} = the number of months of using drug Y for treatment of disease X; and NMonths_{X} = the number of months of disease X.

This proportion does not describe the absolute numbers of treatments, but the patterns of preference for drug use. The proportions can show which drugs are more used for a specific disease, and how the use of a drug changes from disease to disease.

Herd size was also examined as a factor affecting drug use. The Michigan NAHMS herd size stratifications were used: stratum 1 = 10 to 49 adult cows, stratum 2 = 50 to 99 cows, stratum 3 = 100 to 199 cows, and stratum 4 = 200 cows or more. The number of herds selected from each size category were chosen to reflect 1% of all Michigan herds. Ninety-six herds were monitored over the 2 rounds: 32 from stratum 1, 40 from stratum 2, 18 from stratum 3, and 8 from stratum 4.

Because herd size strata were determined by the number of animals in a herd, absolute numbers are an inappropriate measure of antimicrobial use for comparison between strata. Strata with larger numbers of animals will have greater numbers of drug use simply because there are more animals in the population that can be treated. It was more informative to examine the proportions of drugs used within a stratum, using equation 2:

$$\text{Stratum proportional drug use} = \frac{\text{NMonths}_{SXY}}{\text{NMonths}_{SX}} \times 100$$

*Table 1—Animal-months of preventive drug use for selected disease groups by age group**

Disease group	Antibiotics			Sulfonamides			Both drug groups		
	A	B	C	A	B	C	A	B	C
Breeding	0	2	244	0	0	18	0	0	262
Calving	0	0	13	0	0	0	0	0	13
GastroIntest	309	0	1,266	24	0	0	33	0	1,266
Mastitis	0	0	3,226	0	0	4	0	0	3,230
Meta/nutrition +	0	0	0	0	0	3	0	0	3
Multiple system	0	0	10	0	0	0	0	0	10
Respiratory	423	40	14	0	0	0	423	40	14

*Age groups: A = calves (birth to weaning), B = young stock (weaning to first calving); C = cows; †Meta/nutrition = metabolic and nutritional problems (eg nutritional myopathy [white muscle disease], parturient paresis [milk fever]).

where $NMonths_{SXY}$ = the number of months of using drug Y for treatment of disease X in stratum S; and $NMonths_{SX}$ = the number of months of disease X in stratum S.

This proportion does not describe the absolute number of treatments, but the patterns of preference for drug use. The proportions can show which drugs are more used within a stratum, and how the use of a drug changes from stratum to stratum.

Veterinary presence was examined to see whether or not the presence of a veterinarian during diagnosis of disease affected drug use. Proportions were calculated as in equation 3:

$$\text{Veterinary presence proportional drug use} = \frac{NMonths_{VXY}}{NMonths_{VX}} \times 100$$

where $NMonths_{VXY}$ = the number of months of using drug Y for the treatment of disease X with veterinarian present at the time of diagnosis; and $NMonths_{VX}$ = the number of months of disease X with veterinarian presence at the time of diagnosis.

To further examine the effect of veterinary presence on the use of specific groups of drugs by disease groups, odds ratios of using a given drug for a specific disease with veterinary presence at diagnosis were computed by the use of equation 4:

$$\text{Odds of drug Y use for disease X with veterinary presence} = \frac{\left(\frac{NMonths_{VXY}}{NMonths_{VY}}\right)}{\left(\frac{NMonths_{VX}}{NMonths_{V}}\right)} \times 100$$

where

$NMonths_{VXY}$ = the number of months using drug Y for the treatment of disease X with veterinarian present at diagnosis; $NMonths_{VY}$ = the number of months using drug Y for the treatment of all diseases except X, with veterinarian present at diagnosis; $NMonths_{VX}$ = the number of months using all drugs except Y for disease X, with veterinarian present at diagnosis; and $NMonths_{V}$ = the number of months using all drugs except Y for the treatment of all diseases except X, with veterinarian present at diagnosis. This does not compute actual rates of drug use on disease, but allows an evaluation of how the drugs used were distributed by disease and veterinary presence at diagnosis.

Statistical analysis—To examine the effects of herd size on drug use, stratified analysis and χ^2 tests were computed by the use of the statistical program DEPID.[14] Similarly, stratified analysis was used to investigate whether the presence of veterinarians on the farm affected drug use. Odds ratios from stratified analysis were checked for significance at 95% confidence intervals, and χ^2 were tested for significance, using probabilities of 0.05 ($P \leq 0.05$).

Results

Preventive drugs—The largest numbers of preventive drugs for calves were used for respiratory tract and gastrointestinal tract conditions; respiratory tract conditions in young stock; and mastitis, gastrointestinal tract, and breeding problems (including metritis) in cows (Table 1). Most preventive drugs for mastitis were dry treatments. Sulfonamide use was not as widespread as antibiotic use. Sulfonamides were used for preventive use only for gastrointestinal tract problems in calves and breeding problems in cows, and in each case, sulfonamide use made up only a small percentage (7.2% and 6.9%, respectively) of drugs used.

In calves (Table 2) and cows (Table 3), penicillin, tetracyclines, aminoglycosides, and cephalosporins made up 86.6% of all antimicrobial preventives administered. Calves were receiving preventive drugs only for 2 disease groups, whereas cows were receiving drugs for many more disease groups. In the case of cows, only the top 5 diseases being prevented were listed. The other disease groups for which adult cows received preventive drugs were multiple system problems and metabolic/nutrition diseases (10 and 3 head treated over 2 rounds, respectively), which were not included. In young stock, the only disease group receiving drugs were respiratory tract problems, with chlortetracycline being the drug most used.

Table 2—Animal-months of antibiotics and sulfonamides used for disease prevention in calves

Drug Type	GastroIntestinal tract disease	Respiratory tract disease	All diseases
Aminoglycosides	151	201	352
Tetracyclines	126	222	348
Macrolides	31	0	31
Sulfonamides	24	0	24
Penicillins	1	0	1

Table 3—Animal-months of antibiotics and sulfonamides used for disease prevention for top five diseases in cows

Drug type	Mastitis	Gastrointestinal tract disease	Breeding	Respiratory tract disease	Calving	All diseases
Penicillins	1424	0	26	0	0	1450
Tetracyclines	0	1266	51	0	0	1317
Cephalosporin	859	0	0	0	0	859
Aminoglycosides	582	0	60	0	0	642
Novobiocin	474	0	0	0	0	474
Erythromycin	165	0	0	0	0	165
Sulfonamides	4	0	25	0	0	29
Spectinomycin	0	0	30	0	0	30
Polymyxin	0	0	18	0	0	18

Disease treatment—Aminoglycoside and sulfonamide use decreased with age, whereas tetracycline and (to a lesser extent) penicillin use increased (Fig 1). Penicillin, tetracyclines, aminoglycosides, and sulfonamides made up 81.2% of all antimicrobial drugs used for disease treatment.

Herd size—Penicillin use remained fairly steady between herd size strata (Fig 2). Through stratified analysis, only aminoglycoside use showed any pattern in relation to herd size, with use decreasing as herd size increased ($P \leq 0.05$).

For calves, tetracycline use decreased and sulfonamide use increased in the larger herd size categories, and aminoglycoside use decreased substantially in the largest herd group (Fig 3). In young stock, each stratum had different patterns of drug use, and there were no trends noticed (Fig 4). Because this age category had few uses of drugs recorded, it is possible that there were not enough data collected to distinguish any trends.

Because cows received more antibiotics and sulfonamides than any other age group, they make up the basis for overall drug use patterns (Fig 5).

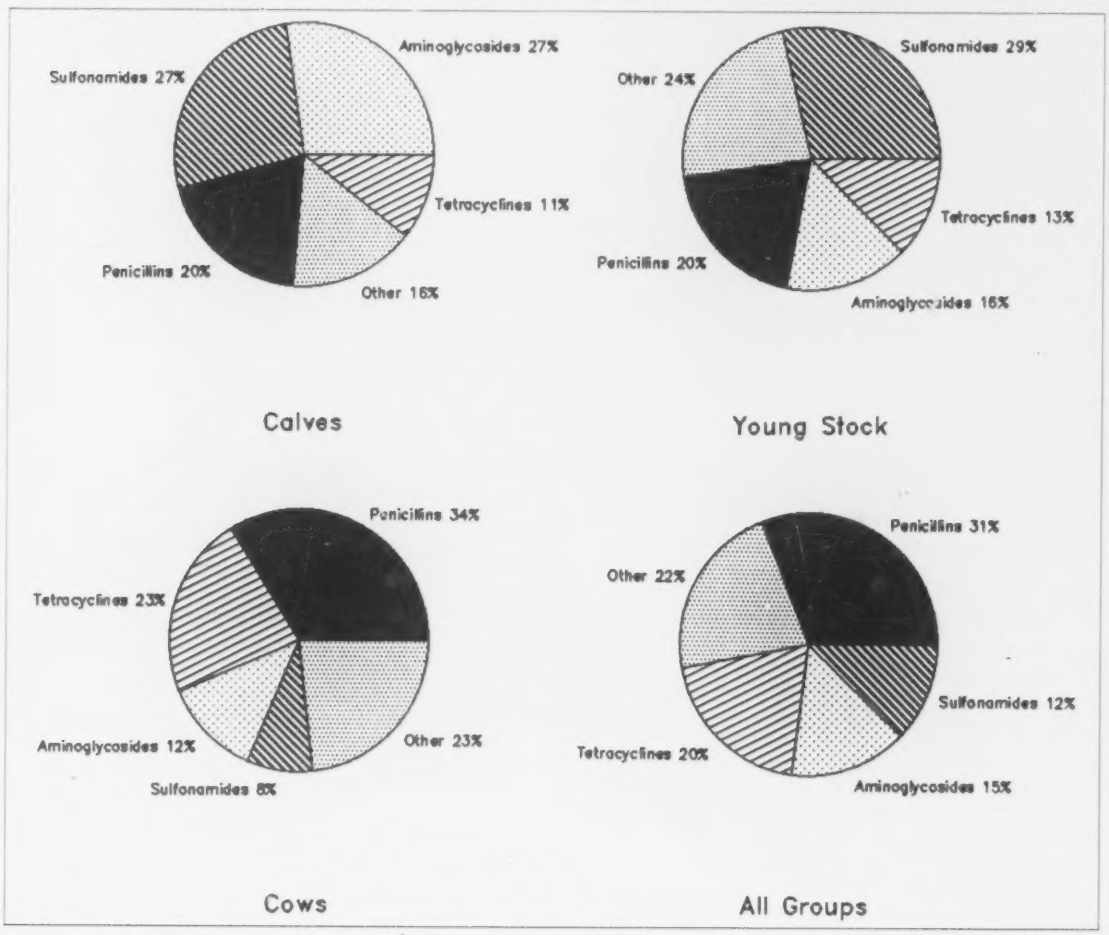

Figure 1—Proportional drug use by age group

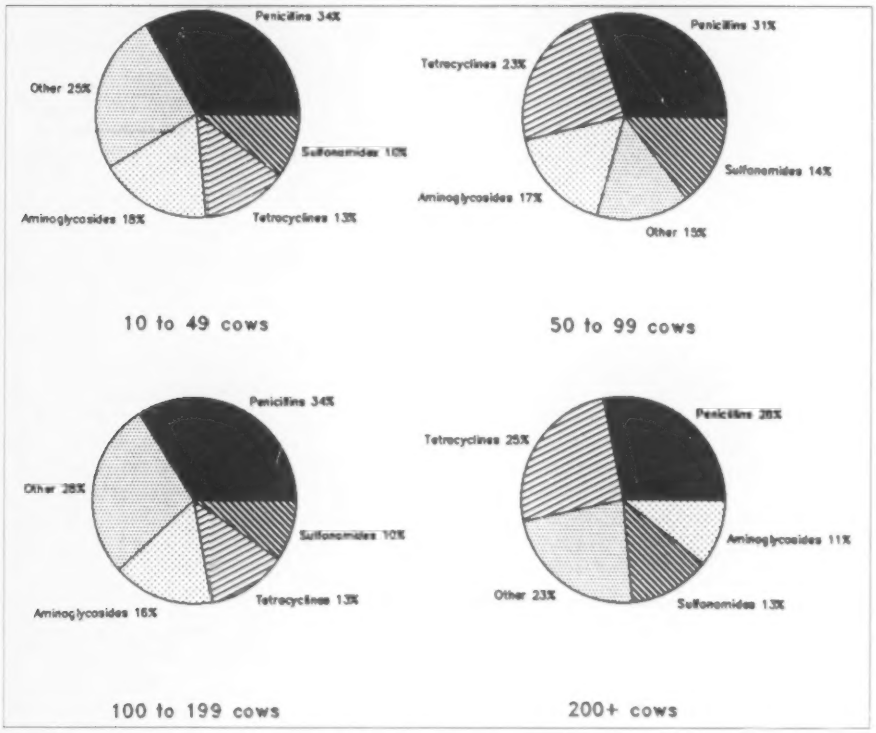

Figure 2—Proportional drug use by herd size stratum

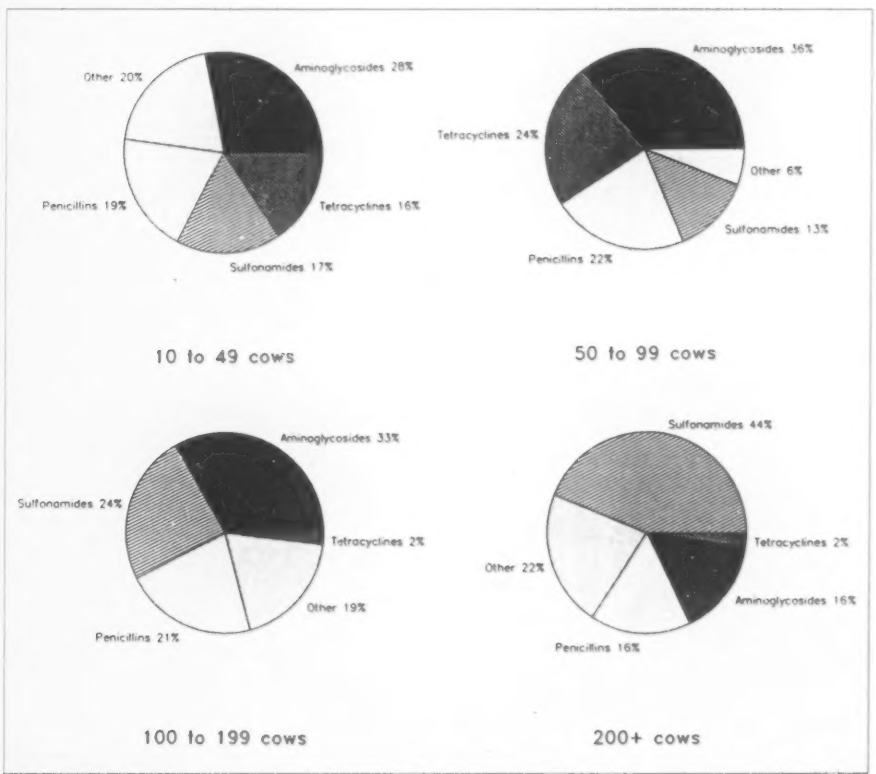

Figure 3—Proportional drug use for calves by herd size stratum

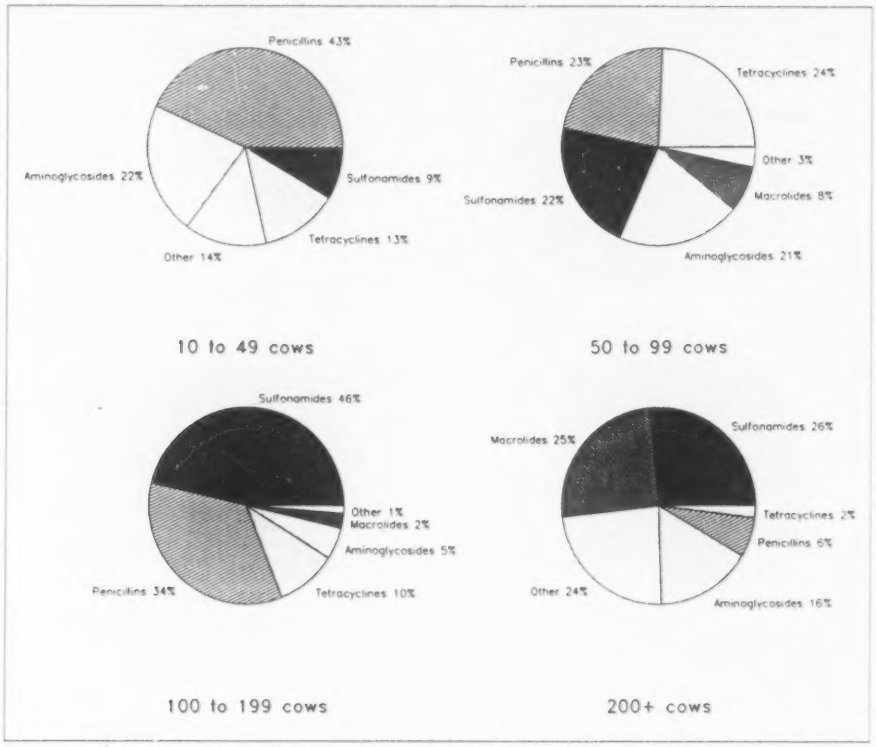

Figure 4—Proportional drug use for young stock by herd size stratum

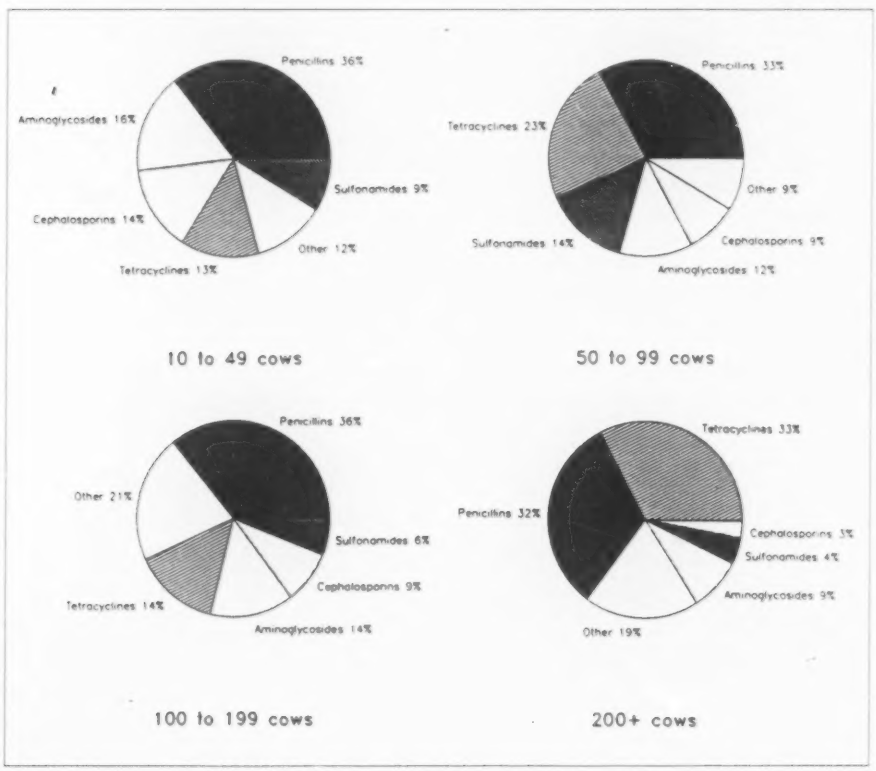

Figure 5—Proportional drug use for cows by herd size stratum

Table 4—Odds ratios for using drugs for all diseases in all age groups with the presence of a veterinarian at diagnosis

Drug type	Calves	Young stock	Cows	All age groups
Penicillins	0.952	0.268*	0.491*	0.558*
Tetracyclines	0.625*	1.164	3.243*	2.749*
Aminoglycosides	0.839	0.513*	0.744*	0.633*
Sulfonamides	1.805*	32.059*	1.371*	1.315*
Cephalosporins	3.359	†	0.418*	0.475*
Nitrofurans	NA	†	2.404*	2.677*
Novobiocin	†	NA	0.207*	0.228*
Spectinomycin	0.059*	1.362	1.777*	1.216*
Macrolides	0.398*	1.092	0.899	0.937
Polymyxins	3.216*	NA	1.210	1.303*
Lincomycin	†	†	0.145*	0.099*
Chloramphenicol	†	NA	NA	†

*Odds ratio is significant (at 95% confidence interval); †Unable to compute odds ratio, one of two counts was 0.
NA = Not available; no use recorded.

Penicillin, aminoglycoside, and sulfonamide use remained fairly constant between strata. Cephalosporins decreased in use with increase in herd size. Tetracyclines were reasonably consistent between strata 1 and 3 (10 to 49 and 100 to 199 cows, respectively). Tetracycline use increased about 10% in stratum 2 (50 to 99 cows), and experienced a large increase in stratum 4 (200 or more cows), with the proportion of use more than double that in stratum 1 or 3.

Veterinary presence—The drug groups were examined by using equation 3 to identify what part of the total use of the drug occurred with and without the presence of a veterinarian at the time of diagnosis for all diseases (Table 4). Because most treatments administered were in cows (n = 14,119; vs 2,703 for calves and 748 for young stock), overall trends closely reflect those trends seen in cows. Tetracycline, sulfonamide, nitrofuran, spectinomycin, and polymyxin use were positively associated with veterinary presence, and penicillin, aminoglycoside, cephalosporin, novobiocin, and lincomycin use were negatively associated with veterinary presence (odds ratios significant at 95% confidence interval). In calves, producers used antibiotics on their own more than with a veterinarian present, with the exception of sulfonamides, polymyxin, and chloramphenicol. The reverse is true for young stock: producers used antibiotic and sulfonamides on their own less than they did with a veterinarian present, with the exceptions of penicillins and aminoglycosides. In cows, veterinary presence was variably associated with the use of drugs.

Table 5—Odds ratios for using specific drugs for diseases in calves with the presence of a veterinarian at diagnosis

Drug type	Gastrointestinal tract disease	Respiratory tract disease	All diseases
Sulfonamides	2.637*	0.907	1.805*
Aminoglycosides	0.570*	1.405	0.839
Penicillins	2.171*	−0.999	0.952
Tetracyclines	0.178*	2.093*	0.625*
Macrolides	0.098*	0.774	0.398*
Spectinomycin	0.090*	0.074*	0.059*
Polymyxins	2.798*	†	3.216*
Lincomycin	NA	†	†
Chloramphenicol	†	NA	†
Cephalosporins	NA	†	3.359
Novobiocin	NA	†	†

See Table 4 for key.

Veterinary presence increased the odds of sulfonamide, penicillin, and polymyxin use, and decreased odds of aminoglycoside, tetracycline, macrolide, and spectinomycin use for gastrointestinal tract problems (odds ratios significant at 95% confidence interval; Table 5). Veterinary presence increased tetracycline use and decreased spectinomycin use for respiratory tract problems in calves (odds ratios significant at 95% confidence interval). Overall, veterinary presence increased odds for sulfonamides and polymyxins, and decreased odds of tetracycline, macrolides, and spectinomycin use for all diseases in calves (odds ratios significant at 95% confidence interval). All lincomycin

Table 6—Odds ratios for using specific drugs for diseases in young stock with the presence of a veterinarian at diagnosis

Drug type	Respiratory tract disease	MultiSystem disease	Gastrointestinal tract disease	Lameness	All disease
Sulfonamides	†	†	NA	NA	32.059*
Penicillins	0.224*	2.963	3.000	0.500	0.268*
Macrolides	1.184	0.178	NA	NA	1.092
Tetracyclines	1.220	0.178	†	†	1.164
Aminoglycosides	0.251*	†	3.000	0.750	0.513*
Spectinomycin	1.857	0.067*	3.000	NA	1.362
Nitrofurans	NA	†	NA	NA	†
Cephalosporins	†	NA	NA	NA	†
Lincomycin	NA	NA	NA	†	†

See Table 4 for key.

Table 7—Odds ratios for using specific drugs for diseases in cows with the presence of a veterinarian at diagnosis

Drug type	Mastitis	Breeding	Calving	Lameness	Gastrointestinal tract disease	All Disease
Penicillin	0.636*	1.457*	1.201	1.398	2.682*	0.491*
Tetracycline	3.075*	1.093	1.110	0.637	0.863	3.243*
Aminoglycosides	1.486*	0.832	0.914	0.164	0.376*	0.744*
Sulfonamides	2.485*	0.447*	0.721*	9.137*	0.430*	1.371*
Nitrofurans	†	0.679*	0.094*	2.815*	2.894	2.404*
Novobiocin	0.398*	†	0.348	†	NA	0.207*
Spectinomycin	1.837*	3.668*	†	NA	†	1.777*
Polymyxins	0.989	2.129*	†	NA	†	1.210
Cephalosporins	0.913	NA	†	NA	†	0.418*
Macrolides	1.320	0.458	†	0.884	0.531	0.899
Lincomycin	0.115*	0.542	†	NA	†	0.145*

See Table 4 for key.

and novobiocin use was without a veterinarian present, and all chloramphenicol use was with a veterinarian present.

Sulfonamides were used in young stock only with a veterinarian present (Table 6). Penicillin and aminoglycoside use were significantly reduced for respiratory tract problems when a veterinarian was present (odds ratios significant at 95% confidence interval), and spectinomycin use was reduced for multiple system health problems when veterinarians were present (odds ratios significant at 95% confidence interval). Low numbers of disease treatments for this age group make conclusions about less frequently used drugs impossible.

On the basis of veterinary presence (using equation 4), odds ratios for drugs used for different diseases in cows varied greatly (Table 7). Overall, veterinary presence was associated with increased use of tetracyclines, sulfonamides, and nitrofurans, and decreased use of penicillins and aminoglycosides.

Discussion

We found that antimicrobial drug use in Michigan dairy farms is widespread, and that several different types of antibiotics and sulfonamides are commonly used. Four important points warrant special attention: patterns of drug use were similar in all herd size categories, drug use varied between the 3 age categories, veterinary presence at the time of diagnosis had effects on the patterns of use of antibiotics and sulfonamides, and producers use antibiotics and sulfonamides more on their own than when a veterinarian is present at the time of diagnosis. Specifically, veterinary presence at diagnosis was associated with increased use of tetracyclines, sulfonamides, and nitrofurans, and decreased use of penicillins and aminoglycosides.

These findings indicate that the presence of a veterinarian on the farm does affect how producers select and use antimicrobial drugs. Three factors should be taken into consideration before producers use drugs on food animals: proper medical indications for use of the specific drug, public health implications of any potential drug residues, and the implications of having drug residues in milk for dairy product processing. Efforts should be made to make producers interact more effectively with practitioners before the use of antibiotics and sulfonamides. Veterinarians can make producers more aware of residue avoidance strategies, and provide them with the information necessary to use these drugs properly.

One unexpected finding was chloramphenicol use in calves when a veterinarian was present. This type of use was found in 1 large herd for 2 months. This herd suffered heavy losses from winter dysentery in their calf crop. Of 29 calves on the farm, all contracted diarrhea and 22 died. In addition to chloramphenicol,[a] the calves received *Escherichia coli* monoclonal antibodies, bovine rota-coronavirus vaccine, trimethoprim and sulfadiazine,[b] and penicillin/streptomycin and methylprednisone.[c] It is possible that everything available was tried, including chloramphenicol.

Recently, sulfonamide boluses for intrauterine use have been taken off the market. This may have a noticeable impact on sulfonamide use for the prevention of breeding problems and treatment of metritis and retained placenta. Removal of these boluses will appear to immediately decrease sulfonamide use, but it is highly probable that other antibiotic preparations will be used in their place, as was the case in the removal of chloramphenicol from food animal use.

Unexpectedly, we found that the most common antimicrobials found in milk, sulfonamides and tetracyclines, were used more with veterinarians present. This finding may be coincidental, or may happen under several scenarios: veterinarians properly provide the drugs in question to the producers, who then do not use the drugs as recommended, extra-label use makes the withdrawal times provided with the drugs irrelevant, or the information on withholding times that are currently available may not be usable. In the first situation, information may be provided, but the need to adhere to withdrawal times may not be reinforced in the farmers' minds. The farmers may not understand the potential problems of ignoring with-

[a]Chloromycetin, Parke-Davis Division of Warner-Lambert Co, Morris Plains, NJ.
[b]Tribrissen, Coopers Animal Health Inc, Kansas City, Mo.
[c]Bio-delta, The Upjohn Company, Kalamazoo, Mich.

drawal times, they may not understand that drugs provided for 1 specific purpose should not be used in other circumstances without veterinary consultation, or they may decide that the potential drawbacks of improper drug use may be outweighed by perceived immediate benefits. In the second scenario, veterinarians themselves use drugs in extra-label circumstances. For example, lincomycin HCl[d] was found to be used in this study, and it is only recommended for use in dogs, poultry, and swine. Withdrawal times may vary between species, and simple adherence to recommended withdrawal times for those species may not be adequate. In the third scenario, information on withholding times provided to the veterinarian may not be adequate. To treat early postpartum uterine infections, oxytetracycline concentrations in uterine tissues must be at least 15 μg/g. However, recommended doses of oxytetracycline are 10 mg/kg of body weight, which result in tissue concentrations < 5 μg/g.[15] Therefore, doses must be increased to meet therapeutic needs, and recommended withholding/withdrawal times will not be adequate considering the increased doses.[16]

With so many different products on the market, it is important to encourage producers to involve their practitioners in the decision to use new drugs in their herds. Different methods should be used to pass this information to producers. Extension programs (particularly at the local level), presentations at producer group meetings, articles in farming magazines, and information via major milk processing groups can be used as pathways to get this information to the producers. The veterinary profession needs to develop specific mechanisms to communicate this information to producers as altruistically as possible. These methods should go beyond the routine veterinarian-client relationship, even though this will always be the primary form of communication. More active interaction between veterinarians and farmers will improve the quality of health care their herds receive, and will ultimately improve producer profits by reducing the risk of antibiotic residues and their attendant costs.

[d]Lincocin, The Upjohn Company, Kalamazoo, Mich.

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Cystine-containing urinary calculi in dogs: 102 cases (1981-1989)

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Summary: *One hundred and seven cystine-containing urinary calculi from 1 female and 101 male dogs were analyzed. Cystine-containing calculi accounted for 2% (107 of 5,375) of all canine urinary calculi submitted to the urinary stone analysis laboratory from July 1981 through December 1989. Male dogs that formed cystine calculi were compared with 3 other canine populations to determine whether certain breeds were apparently at increased or decreased risk for cystine calculus formation. In one or more of 3 population comparisons, significantly increased risk of cystine calculus formation was found in Mastiffs, Australian Cattle Dogs, English Bulldogs, Chihuahuas, Bullmastiffs, Newfoundlands, Dachshunds, Basenjis, Australian Shepherd Dogs, Scottish Deerhounds, Staffordshire Terriers, Miniature Pinschers, pitbull terriers, Welsh Corgis, Silky Terriers, and Bichon Frises. Significantly low risk of cystine calculus formation was found in German Shepherd Dogs, Poodles, Schnauzers, and mixed-breed dogs.*

Cystinuria in dogs results from an inherited defect in the renal proximal tubular transport system that allows excessive urinary excretion of cystine, and variably other amino acids.[1-4] Because it is insoluble in urine, precipitation of cystine and the formation of cystine calculi is a potential problem; otherwise, loss of the amino acid(s) in the urine has no clinical significance.[1] Although cystinuria may occur in male and female dogs,[1,5] cystine calculi have been reported only in males, with 2 exceptions.[6,7]

The prevalence of cystine calculi reported in the literature varies greatly. In Europe, cystine calculi account for 15 to 40% of all calculi from dogs.[3,8-10] In the United States, the prevalence of cystine calculi is much lower. Most studies cite a prevalence of 2.4 to 3.8%,[11-13] but reported prevalence has been as high as 22%.[6] The mean age at the first episode of cystine urolithiasis is approximately 4.8 years,[1,6,9] which is younger than for other types of calculi.[6]

The exact pattern of genetic transmission of canine cystinuria is obscure because it does not follow a simple Mendelian pattern.[1] Inheritance probably is sex-linked; however, an incomplete autosomal recessive mode of inheritance cannot be conclusively ruled out.[1,14-16] If canine cystinuria is genetically transmitted, the genes must be widespread in the dog population because cystinuria has been found in a large number of diverse breeds as well as in mixed breeds.[6-8,11]

Cystine calculi have been reported most frequently in Dachshunds.[1,5,6,8,10,11] Other breeds with frequently reported occurrences of cystine calculi include Basset Hounds,[6,11,17,18] Beagles,[6] Bulldogs,[6-8,17] Chihuahuas,[6,7,17,18] Welsh Corgis,[8,18] Miniature Schnauzers,[6] Poodles,[6] and mixed-breed dogs.[6-8,18] However, in most studies, an attempt was not made to determine the relative risk of these breeds for the formation of cystine calculi. The primary reason cited was lack of information about the breed distributions in the populations from which the dogs came.[8,11]

The purpose of the study reported here was to review a large number of cases of cystine urolithiasis and determine whether certain breeds of dogs are apparently at increased or decreased risk for cystine calculus formation.

Criteria for Selection of Cases

A computer-assisted search of records of the urinary stone analysis laboratory, University of California disclosed 107 specimens of cystine-containing urinary calculi from 102 dogs. Records surveyed were of 5,375 calculi that were submitted for analysis between July 1981 and December 1989.

Materials and Methods

Calculus specimens—Specimens had been surgically removed and mailed to the laboratory for determination of their mineral composition. The size, weight, and physical appearance of each

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Table 1—Risk (odds ratio) of cystine calculus formation in male dogs, by breed, compared with other canine populations*

Breed	Cystine calculi population (n = 108)	Stonelab population† (n = 2,530)			VMTH population‡ (n = 46,305)		
	Dogs	Dogs	Odds ratio	(P)	Dogs	Odds ratio	(P)
Mastiff	9	9	26.0	(0.0)	103	41.6	(0.0)
Australian Cattle Dog	8	9	22.9	(0.0)	34	111.1	(0.0)
English Bulldog	12	38	8.4	(0.0)	277	21.2	(0.0)
Chihuahua	9	33	7.0	(0.0001)	422	10.1	(0.0)
Bullmastiff	5	6	20.8	(0.0001)	47	48.7	(0.0)
Newfoundland	4	6	16.5	(0.0001)	117	15.5	(0.0)
Pitbull terrier	2	13	3.7	(0.09)	27	33.0	(0.0)
Dachshund	9	52	4.4	(0.0002)	1,363	3.1	(0.0015)
Basenji	3	6	12.2	(0.0004)	110	12.2	(0.0002)
Miniature Pinscher	1	3	8.0	(0.07)	24	18.4	(0.005)
Bichon Frise	1	40	0.59	NS	25	17.6	(0.0062)
Welsh Corgi	2	24	2.0	NS	129	1.9	(0.007)
Australian Shepherd Dog	3	14	5.2	(0.01)	536	2.5	NS
Scottish Deerhound	1	1	24.1	(0.025)	36	12.2	(0.013)
Staffordshire Terrier	1	1	24.1	(0.025)	224	2.0	NS
Silky Terrier	1	14	1.7	NS	59	7.5	(0.05)
Alaskan Malamute	1	4	6.0	NS	203	2.2	NS
Samoyed	2	16	3.0	NS	433	2.0	NS
Scottish Terrier	1	9	2.7	NS	182	2.4	NS
West Highland White Terrier	1	10	2.4	NS	118	3.7	NS
Cairn Terrier	1	12	2.0	NS	100	4.4	NS
Basset Hound	1	20	1.2	NS	336	1.3	NS
Great Dane	1	16	1.5	NS	827	0.52	NS
Poodle	3	135	0.52	NS	2,820	0.45	NS
Yorkshire Terrier	1	140	0.16	NS	328	1.33	NS
Dalmatian	1	230	0.10	NS	363	1.21	NS
Schnauzer	2	275	0.16	(0.01)	527	1.67	NS
German Shepherd Dog	1	81	0.29	NS	4,491	0.09	(0.016)
Mixed breed	19	418	1.1	NS	11,494	0.66	(0.10)
Labrador Retriever	0	68	0.16	NS	2,619	0.08	(0.073)
Golden Retriever	0	57	0.21	NS	1,384	0.15	NS
Doberman Pinscher	0	82	0.14	NS	1,602	0.13	NS

*Breeds are listed in approximate decreasing order of statistical significance (*P* value; 2-tailed), compared with at risk (OR > 1) breeds at the top, and protected (OR < 1) breeds at the bottom. Three common breeds with no cystine stones are included for comparison (zeros were replaced by 0.5 for odds ratio calculations). †Male dogs forming calculi of any mineral type, for which the calculi were submitted to the urinary stone analysis laboratory (Stonelab) from July 1981 through December 1989 (n = 2,530). ‡Male dogs admitted to the Veterinary Medical Teaching Hospital (VMTH), University of California, from January 1969 through December 1988 (n = 46,305).

NS = not significant (*P* > 0.10).

specimen were recorded, and a determination of the mineral composition was made by crystallographic analysis, using polarized light microscopy.[19] A qualitative chemical spot test[a] also was used as an aid in the analysis of some specimens.

Dogs—The age, breed, and gender of the affected dogs were recorded as were location of the calculi within the urinary tract and the state in which each dog resided. An attempt was made to determine the number of episodes of calculi preceding the episode from which the specimen was submitted.

Statistical methods—To determine whether certain breeds of dogs were apparently at increased or decreased risk for cystine calculus formation, the male dogs in this study (cystine calculi population) were compared with 3 other canine populations: (1) male dogs that formed calculi of any mineral type that were analyzed by the urinary stone analysis laboratory between July 1981 and December 1989 (Stonelab population); (2) male dogs admitted to the Veterinary Medical Teaching Hospital (VMTH) from January 1969 through December 1988 (VMTH population); and (3) dogs seen in 2 community surveys of pet owners in northern California (general population).[20,21] For each comparison, odds ratios were calculated and tested for significance with a z-test.[22]

[a]Oxford stone analysis set, Lancer Div, Sherwood Medical Industries Inc, St Louis, Mo.

Results

Of 5,375 canine urinary calculi submitted to the laboratory, 107 (2%) contained cystine. The cystine calculi were submitted from veterinary practices in 21 states. The state of residence of dogs with cystine calculi was similar to that of dogs with urinary calculi of all other mineral types that were analyzed by the laboratory. In particular, more than half of the specimens of each type of calculus (58 of 107 cystine; 3,024 of 5,268 other) came from dogs from California. Of the remaining specimens, most came from dogs in states in which schools of veterinary medicine are located.

The cystine calculi came from 101 male dogs and 1 female English Bulldog (specimens were analyzed from 2 episodes of calculus formation from each of 5 dogs). Twenty-seven breeds and a mixed-breed group were represented. Mixed breeds were most often represented (19 specimens from 17 dogs), followed by English Bulldogs (13 specimens from 12 dogs), Chihuahuas and Dachs-

Table 2—Risk (odds ratio) of cystine calculus formation in selected breeds of male dogs, compared with dogs of either gender† in 2 community surveys in California*

Breed	Cystine calculi population (n = 108)	Yolo County population[20]			Alameda/Contra Costa Counties population[21]		
	Dogs	Dogs	Odds ratio	(P)	Dogs	Odds ratio	(P)
Chihuahua	9	23	3.13	(0.005)	10,773	1.83	(0.08)
Dachshund	9	27	2.66	(0.014)	12,319	1.59	NS
Basset Hound	1	8	0.94	NS	1,548	1.37	NS
Mixed breed	19	293	0.38	(0.0002)	118,745	0.19	(0.0)
Poodle	3	111	0.18	(0.004)	41,616	0.13	(0.0004)
German Shepherd Dog	1	42	0.17	(0.083)	27,224	0.07	(0.008)

*Other breeds experiencing cystine calculi were sufficiently rare that those breeds did not appear in the breed distribution for either the Yolo County survey of 1,091 households or the Alameda/Contra Costa survey. †Breed by gender distribution was not published in either survey. NS = not significant ($P > 0.10$).

hunds (9 specimens each), Mastiffs (9 specimens from 8 dogs), and Australian Cattle Dogs (8 specimens from 7 dogs; Table 1).

When the population of male dogs with cystine calculi was compared with the Stonelab population, significantly ($P < 0.05$) high risk of cystine stone formation, relative to the formation of stones of any type, was found in 11 breeds (Table 1). These same breeds, with the exception of the Australian Shepherd and the Staffordshire Terrier, also were found to have significantly increased risk of cystine stone development when compared with the VMTH population. In addition, 5 other breeds had significantly ($P < 0.05$) increased risk of cystine stone formation when compared with the VMTH population (Table 1). A "protective" value of breed was found for German Shepherd Dogs, Labrador Retrievers, and mixed-breed dogs when the VMTH population was used as the comparison group, and for Schnauzers when the Stonelab population was used as the comparison group.

In comparison to the general canine population studied in 2 northern California community surveys (Table 2), significantly ($P < 0.05$) increased risk of cystine calculus formation was found for Chihuahuas and Dachshunds, confirming the high risk seen in these breeds in the 2 clinical comparison groups. In this community-based comparison, Poodles, German Shepherd Dogs, and mixed-breed dogs had significantly ($P < 0.05$) low risk of forming cystine calculi.

Fifty-one (48%) of the specimens were from the first episode of calculus formation. The ages of these dogs ranged from 10 months to 11 years (mean, 4.5 years). Thirty-six (34%) specimens were from the second episode of calculus formation. The ages of the dogs in this group ranged from 1 to 14 years (mean, 5.4 years). Two specimens were from the third episode of calculus formation and 1 specimen was from the sixth episode of calculus formation in an 8-year old West Highland White Terrier. Information regarding number of episodes was not available for 17 (16%) specimens. All but 1 of the specimens were removed from the urinary bladder or the urethra. The only exception was a renal calculus specimen that was removed from a Bullmastiff.

Ninety-two (86%) of the specimens were composed only of cystine. Fifteen (14%) specimens were composed of mixtures of mineral substances. Fourteen of these contained cystine plus 1 additional mineral substance, which was either struvite (5 instances), urate, silicate, or oxalate (2 instances each), or calcium apatite (1 instance). The noncystine mineral substance could not be identified in 2 specimens. A single specimen contained 3 minerals: cystine, brushite, and urate. Thirteen of the 15 mixed specimens contained 2 distinct layers; 2 were composed of a single layer.

Discussion

The cystine calculus found in the female English Bulldog was previously reported.[7] This dog was not included in the population comparisons.

The mean age of the dogs at the first episode of cystine calculus formation (4.5 years) is similar to that reported by others.[1,6,9] The mean age of dogs at their second episode was approximately 1 year older (5.4 years). It has been stated that, in the absence of treatment, cystine stones commonly recur within 6 to 12 months.[1] Recurrence rates for cystine calculi of 47 to 75% have been reported.[9,23]

Cystine calculi accounted for 2% of all urinary calculi in dogs in this study, a value slightly less than in studies previously reported in the United States.[11-13] The prevalence of cystine calculi reported in the literature varies greatly.[3,6,8-13] These differences probably reflect a number of factors. As found in our study, breed predispositions apparently exist for cystine calculus formation, thus the prevalence of cystine calculi may vary with the breeds of dogs encountered in each survey. Prevalence as high as 60% has been reported for cystine calculi when only selected breeds are included.[17] Even among breeds predisposed to cystine calculi, the prevalence may vary depending on the genetic strain, the geographic location (eg, Europe vs United States), and the time of collection.[24] The method used to analyze the calculi also is a crucial factor. Quantitative analysis is far superior to qualitative analysis, with < 50% agreement between the 2 methods in the case of cystine calculi.[12,25] Because the recurrence rate of cystine calculi is higher than for most other types of calcu-

li,[9,23] prevalence will vary depending on whether single or multiple episodes are included in the statistical data analyzed.[6]

Selection of suitable populations for study and comparison is a formidable task. No single comparison group is perfect; each has its inherent bias. For this reason, 3 population comparisons by breed were made in this study. Although there was some variation in breeds considered at risk of forming cystine calculi, depending on which population was used for comparison, results from all 3 populations were in general agreement.

It has been stated in a similar study of calculi from widespread sources, that lack of knowledge about the popularity of the various breeds within their respective populations of origin precludes formulation of the relative risk of each breed for urolith formation.[11] We faced a similar dilemma in this study, because calculi were submitted from 21 states. However, as a subset, the geographic distribution of the cystine calculi population was generally similar to the geographic distribution of the larger Stonelab population to which it was compared. The purpose of this first comparison (cystine calculi population vs Stonelab population) was to determine cystine-specific risks in dogs forming calculi.

The second comparison, that of cystine calculus-formers with dogs receiving veterinary care (VMTH population), is of particular clinical interest to veterinarians. This comparison is the type most often used in epidemiologic surveys. Hospital populations are biased in that they represent the distribution of dogs with conditions requiring veterinary attention, and may not be representative of the total canine population. Unfortunately, workable alternatives are limited. For example, American Kennel Club figures include only a small proportion of all dogs and do not include the most popular category, mixed breeds. Because more than half of the calculi in this study were submitted from California, comparison with hospital admissions primarily from California was deemed appropriate.

The third and most general comparison made was of male dogs having cystine calculi with the distribution of dogs in 2 northern California communities. This type of comparison is useful in assessing the risks of urolith formation in the various breeds of dogs in the community, irrespective of whether they are receiving veterinary care. Although the county surveys included dogs of both genders, the published reports indicated approximately equal gender ratios (eg, 1.04 in Alameda County[21]). Although these surveys were conducted 20 years ago, the breeds that were popular then (mixed-breed dogs, Poodles, German Shepherd Dogs, Dachshunds) remain among the most popular now, as reflected by their high incidence in the VMTH population.

Although the odds ratios for individual terrier breeds were not often significant, as a group, they appeared to have a higher than expected risk of cystine calculus formation. This may be an illustration of a heritable defect that is more frequently manifested among breeds with a close genetic relationship. In spite of the fact that cystinuria has been identified in a large number of diverse breeds, published pedigrees of inheritance of cystinuria represent only terrier breeds.[14,16,26] Further investigation into the inheritance of cystinuria in nonterrier breeds with apparent high risk of cystine calculus formation (eg, Mastiffs, Bullmastiffs, Australian Cattle Dogs) might be warranted. In addition, other factors should be considered besides the inheritance of a renal transport defect, which might predispose certain breeds to the formation of cystine calculi.

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